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EDUCATION AND THE PETROLEUM INDUSTRY.

By Professor V. C. Illing [Member].

Introduction.

It is a sound instinct that has raised the cry for a broader and better education in the Britain we hope to build after the war, sound because it indicates a true searching of hearts, a deep dissatisfaction with some features of the world of yesterday, and a clear conviction that we must and can build better in the future. So far as education is not the mere accumulation of unassimilated facts, but is rather a moulding of character by knowledge rightly used, it cannot be denied that more education for all would lead to a much better world. We must, however, beware in this mood of disillusion and endeavour, lest in our eagerness to improve we fail to value all that was good in the past and destroy some of our most valuable heritages; nor should we forget that the building of new systems needs hard labour, money, and time.

The incidence of heavy taxation which has borne unduly on the middle classes has raised financial problems in the public schools, which see in prospect a considerable reduction in the number of their pupils unless State-endowed Bursaries can provide a solution. At the same time criticism of these schools, merited perhaps in some few instances, but on the whole biassed and mischievous, has given the iconoclasts an excuse to indulge their instincts for destruction, whilst others have visualized one common type of education in the future to which all must conform. These are bewildering thoughts to those of us who see much good in the present system, even if it be capable of great improvement, and we can only hope that the natural instincts of our people to hasten by degrees will preserve and improve our educational system rather than destroy and attempt to rebuild it.

It is mainly in the home and in the school that the basic foundations of character and knowledge are laid. On these foundations the Technical Colleges, Universities, and eventually Industry may build structures of imposing dimensions, but their security will depend on whether the foundations have been truly laid. It is therefore to the homes of England and her schools that we must look if we want our future citizens to be worthy of her traditions and leadership.

The members of this Institute, whose interests are intimately bound up in the well-being of the petroleum industry, cannot but be vitally concerned in the quality of the young men and women who are to carry on in the future. It is one of our first duties to ensure that they be carefully selected, properly trained, and well led, for if we believe that our industry is unique, as we all most certainly do, then nothing but the best is good enough.

Integration of the Petroleum Industry.

Before we consider how this ideal of education is to be achieved, it is necessary that we examine our own industry in detail, to find out what is

expected of the men who enter it and what kind of training will best fit them for the type of work they are asked to do.

In speaking of the petroleum industry above, the word "unique" was used advisedly, for it can be claimed that no other industry has harnessed the sciences so completely in the service of the community. Its function has been to turn the natural product petroleum to purposeful use, but it has taken so broad a view of its duty that it might well write as its motto "From the depths of the earth to the door of the consumer." What other industry controls so completely every phase of the development of its products? It searches the wide world for its raw materials, drills for and produces them, and then converts them into a galaxy of products, each of which is carefully controlled in its manufacture to suit the purpose for which it is made. It carries these products in its own ships, pipe-lines, and tank waggons to wherever people congregate, and watches men's needs so carefully that it anticipates rather than answers their demands. It has revolutionized transport with the fuels which it has developed for the internal-combustion engine, and now it bids fair to multiply enormously the range of its products in every phase of life. No other industry can claim such breadth of achievement, such versatility in application. Yet the oil industry is still young—barely eighty years, if we exclude the primitive efforts of antiquity. Its main vigorous growth has been achieved in the last thirty or forty years, and has been largely bound up with the development of the motor-car.

No chart of oil production nor catalogue of the numerous oil-fields discovered can convey more than a glimpse of the real history of its phenomenal growth, the enormous difficulties which it has overcome, the unfaltering courage and perseverance which it has shown. These virtues have produced the great oil companies with their ramifications over the wide world, the sturdy, independent companies which maintain their position by being deeply anchored in their environment, the innumerable individualists who are prepared to back their skill and their opinion against all comers. They have created the community of oil-men who, though scattered through the world and speaking many languages, are bound together by their common problems.

There are, it is true, other sides of this picture which are not so pleasing. The early rhythm of boom and slump, the wastefulness of primitive methods of production, the unfortunate features of intense competitive drilling—these were the growing pains of a young and vigorous industry, and most of them have been removed or are being eliminated by the good sense and spirit of co-operation which, curiously enough, can live side by side with vigorous competition. We have learned in the hard school of experience that co-operation brings good to all, and we can justly claim that in its relative freedom from strikes and lock-outs the petroleum industry sets a standard of which it can well be proud.

As an industry grows up and becomes more complicated its members inevitably pay the price of a gain in efficiency by a loss of independence. They lose, too, the mental stimulus of being able to visualize the organization as a whole as they become immersed in their own immediate problems. In a vague and general way each of them is aware of the fact that in the body of the industry there are other members, other limbs which carry

out different functions. They are also aware, perhaps more dimly, that without these other limbs they would be unable to function properly; that their work might even cease to exist. They know, of course, that it is the chief concern of the refiner to transform the crude into a series of products which will satisfy the public needs; that the production engineer is mainly concerned in the recovery of the oil from the depths of the earth, whilst the geologist plays his part in discovering and developing new oil resources without which the industry would die. Few, however, are sufficiently familiar with the difficulties which are associated with each of these separate operations and the way in which they have grown to their present stature. To appreciate these difficulties and how they have been overcome is the true foundation for that perfect co-operation based on mutual respect.

The fact is that our industry has grown rapidly and almost spontaneously wherever oil could be found or a market could be served. To do this it attracted to itself in its early days adventurous spirits of every type and training. Only as it has grown up has it segregated itself, so far as its staff is concerned, into bands of technicians, such as geologists, chemists, engineers, etc., each particularly concerned with one phase of its activities. This is a great source of strength so long as it is associated with safeguards, but it carries within itself certain latent sources of weakness which need to be watched carefully. Where operations are uniform and stereotyped a form of procedure can be adopted which meets the case, and it can be carried out by the individual whose training fits him peculiarly for the particular work; but where the factors are changing or new difficulties are continuously being faced, it is the exception rather than the rule to find that the solution lies completely within the boundaries of a single science. This is particularly true of the oil industry, in which progress has become more and more a matter of team work, not only between similar scientists, but among scientists and engineers of very different training.

For purposes of effective study, Science has been segregated into a series of units—physics, chemistry, botany, zoology, geology, etc.—wherein matters which have a common field of interest are considered separately. By so doing the interest and training can be concentrated in those directions which are most effective for the particular field of inquiry. This is essential for success where the field of interest is so vast and knowledge is expanding at such a rapid rate, but the partitioning must not blind us to the fact that there are no real boundaries between the sciences. They are merely different aspects of the one natural world, convenient sub-divisions of a single universal truth. There is, moreover, an undoubted danger in building up these stereotyped units, for a No-man's-land is apt to emerge in the boundary areas which can eventually only be bridged by the creation of new scientific labels, new fields of study. Normally there would be no harm in this were it not for two tendencies: firstly, the growth of knowledge leading to a much greater degree of specialization, and still further segregation; and secondly, the development of scientific jargon which makes one science almost unintelligible to another. Both these processes are inevitable, but their effects should be carefully controlled, and one can only hope that the second tendency

will be kept within reasonable bounds by the good sense of our scientists. It is all very well to coin a new word in order to attain a greater precision of expression, but we should never forget that in so doing we are creating a new language which is bound in the end to limit our audience.

It would, I think, be generally agreed among scientists that progress in the sciences is apt to be exceedingly irregular, the slowest rate of advance being usually in the boundary areas between the sciences. Collaboration between the different sciences, which is essential in these boundary zones, is apt to be less effective than it is within the bodies of the sciences. This is not due to a lack of the co-operative spirit, but rather because it requires the merging of different trains of thought and different methods of attack.

The impact of this partitioning of the sciences on an industry like petroleum, which casts its net over so broad a field, is bound to have interesting and far-reaching results; nor can one fail to note that these results are only in the main beneficial. The problem is solved by collaboration, by creating teams of workers whose flexibility and breadth of knowledge are ideal weapons with which to solve the problems, and by developing societies in which all branches of some particular industry are studied.

It is not, however, always easy for the scientist to find his feet in these industrial fields, especially if his training has been on highly specialized lines. He may, of course, be needed for his own particular field of study alone, though his contribution will be the better for his appreciation of its rôle in the general picture. The main body of scientists in the petroleum industry are, however, members of teams, and the value of their work as a whole depends not only on their own contributions, but on the building of separate units of work into a composite picture. The success of this process depends not only on the guiding hand, but on the ability of each worker to appreciate the contributions of the others and to work with them effectively. Thus we may see physicists, chemists, geologists, and engineers all making their individual contributions to achieve the one desired result. As examples of this collaboration between scientists and engineers it will be appropriate to make a rapid survey of some of the sections of the petroleum industry, in order to obtain a picture of the processes at work.

(*a*) *Exploration.*

The search for petroleum is not the prerogative of any particular science. Indeed, with such an elusive substance, discovery is often the result of several lines of attack. On the other hand, there can be no doubt that, in so far as it is the function of geology to study the natural history of petroleum, the intelligent search for oil must largely be guided by the philosophy built up by the geologist. The tools, however, which are used by the scientist and engineer in the search for oil are many and various, and they are daily increasing in their scope. It is important to discriminate between the guiding principles on which a search for petroleum should be based and the tools by which this end is accomplished. In a new area of exploration it would undoubtedly be the function of the geologist to assess the chances of success and to draw up the general strategy of attack, but the plan of campaign would inevitably require more than the mere application of geological method. The help of geophysicists

using various selected methods of delineating buried structure, that of the chemist in examining surface samples, and finally that of the engineer in the final drilling campaign would probably all play their part in an efficient scheme of testing.

Where the general geological picture is already well known and the area has previously been examined by geological means, it may afterwards be combed over with success by new prospecting tools. Thus, for instance, in many parts of the U.S.A. areas have been successively attacked by geologists, torsion-balance crews, refraction and finally reflection seismic parties. In each of these campaigns it must be remembered that the party is not attempting to find oil directly, but to discover geological structures, which, on the principles worked out as a part of geological philosophy, are favourable to the accumulation of oil within the rocks known to exist in the area. Thus, whatever the tool used in the attack, we always come back to two geological requisites for success, the stratigraphy of the area and the details of the structure. Both of these come directly within the purview of the geologist, and without a sound geological training it is impossible to appreciate their true significance in any given area.

This latter point cannot be too strongly stressed, not merely because it illustrates the true function of geophysics in exploration—*i.e.*, the discovery of buried geological structures by physical measurement—but because it calls attention to another feature recognized freely by eminent geophysicists: that their methods of attack have advanced at a greater rate than their theories of interpretation. The reason for this is the simple fact that interpretation of geophysical data must require the insight of a geologist, because the final picture in which they are portrayed must be in geological terms.

The collaboration of geologist and geophysicist is therefore one of those typical examples of the blending of the sciences with which our industry abounds. Short of drilling, the physicist possesses the only tools for direct measurement into the earth, but the results which he obtains must be presented in geological terms, and therefore need geological control, particularly if they are to be obtained as economically as possible. The geologist's knowledge of the stratigraphy of the area and the general structure, together with other indirect methods of structural interpretation, enable him to reject or select the various possibilities suggested by the physical data, and the collaboration of the two sciences during the period of the survey is undoubtedly the best method of carrying out any form of geophysical examination.

This point has been gone into at some length because the relations of geology and geophysics in oil-finding have been much misunderstood. They are often regarded as rivals, instead of as allies. Faults undoubtedly have been present on both sides, each science failing to realize the immense help to be obtained from the other. The differences are, however, more deep-seated in their origin. They go back to the different methods of training in the two sciences. The physicist is trained to measure with great accuracy, and is interested only in the physical side of the picture he is creating; the geologist is keenly alive to the living meaning of the picture depicted and is interested mainly in what it represents in terms of

geological history. The points of view are fundamentally different, and they can only be brought together by mutual understanding between the two groups of scientists.

That there have been exceptions to these sweeping statements is happily true, and the expanding use of geophysics in oil geology has owed a great deal to the encouragement of far-sighted geologists, among whom the writer remembers with gratitude the names of de Böckh, De Golyer, and Barton. These and many others laboured patiently to bring the new weapons into successful use and put them on secure foundations.

Returning to the question of oil exploration, whilst geology sets the field and conducts most of the search, it is not alone responsible for the discovery of oil. The true function of geology is rather in the elimination of unnecessary risks, the balancing of the main chances, the planning of the drilling campaign to test the area as economically as possible. Many oil-fields have been found without geological help, and undoubtedly many oil-bearing structures still buried beneath the earth will be found in the future by random effort rather than by applied geology, with or without the help of geophysics. The plain fact is that there are some types of pools which cannot be discovered by any known method of scientific approach, but can only be found by the courage of the oil operator who is prepared to accept very great risks. It is the duty of the oil companies to reduce their risks in oil-field exploration, and geology offers the soundest method of achieving this end. This is shown by the fact that geology has been responsible for the major number of oil discoveries, and also that, in spite of the relative exhaustion of the shallower pools and those which are easy to discover, the general percentage of failures in wildcat drilling has not tended to rise. It would be churlish, on the other hand, not to pay a great tribute to the success of the geophysical tool, particularly in recent years, and the writer would regard future oil discovery as a form of geological investigation in which geophysics plays an essential part.

Until recently we have been discovering new oil-fields at a rate which has kept pace with the increased demand, though we cannot guarantee how long this happy state will continue, and for the time being the war has sadly interfered with the rate of new discovery. This success has been due to the great expansion in our knowledge of the types of structural conditions which tend to produce and conserve oil-pools, to the improvement of our methods of direct and indirect attack, and to the great advances in the efficiency of drilling operations. To these we must also add the new methods of geophysical investigation when the drilling has actually reached the oil-bearing formations, notably the Schlumberger surveys giving a simple and rapid means of recognizing the positions of the reservoir rocks and of identifying their contents. Above all, the progress is due to the teamwork of groups of scientists and engineers who form the nucleus of the staffs of operating companies. Such exploratory teams are only built and welded into successful instruments of discovery by years of experience. Their strength depends largely on the perfect co-ordination of each individual's contribution, and the wise oil company treasures such teams as the best insurance for its future success.

Teams such as these are only built by men who understand the functions

of each individual member, and they are only possible where the individuals know how to work together to obtain a combined result. For the success of such work each man must know the part he has to play and its function in the general scheme. He must also value the help he can obtain from his colleagues and that which he himself can contribute to their work.

The foregoing does not imply that oil cannot be discovered by the individualist, but only that it is getting more difficult as the fields to be discovered get fewer and more deeply buried. The task demands more and more help from all possible methods of investigation, and therefore it needs scientists of broad vision, who not only know their own work, but can call on brother scientists to help them out of their difficulties. The demand is therefore for two almost contradictory attributes: a broad basis of scientific knowledge and a greater degree of specialization in one particular direction. Whilst these two requisites appear mutually antagonistic, they need not necessarily be so if we choose to make the first the prime objective of our educational system, and allow the second to be built up largely by experience.

The author has dwelt at some length on the need for co-ordination of the sciences and engineering in oil discovery in order to exemplify the problems common to every phase of the industry and as a basis of his plea that though we need the highest quality of technical preparation yet this must not be bought at the price of too early and extreme specialization. The foundations of our knowledge must be broad and deep if the work is to reach the highest levels.

(*b*) *Oil Production.*

The succeeding sections need not be dealt with at such length, because they each and all point the same moral. Production combines the two problems of drilling for oil and collecting it at the surface. This is essentially the task of an engineer, but it is not one in which engineering alone can solve all the involved problems. The successful extraction of the largest possible quota of oil from an oil reservoir demands an intimate knowledge of the structure of the reservoir rock, its porosity, and its permeability. Associated problems are the presence of water-bearing formations, of free gas, gas in solution, the sources of reservoir pressure, and the type of movement of gas, oil, and water within the structure as the pressures and the contents change. These are studies in which geology and physics are intimately concerned, so that exploitation calls for an intimate knowledge of both these subjects if it is to be carried out with full efficiency. The modern conception of unit production, the conservation of reservoir pressure, systems of re-pressuring, gas drive, and water drive, are all the outcome of the collaboration of the sciences. Furthermore the recent application of electric logging of wells has revolutionized well completion methods by its clear-cut identification of the levels at which gas, oil, and water exist in the formations. It has also revolutionized the methods of subsurface geological investigation in some fields, rendering it possible to obtain a clearer picture of correlation than by any other means. Nor can the production problems within a field be adequately faced without the use of chemical science. Modern

processes of drilling are greatly dependent on efficient mud control, and a whole science of the doctoring of muds has arisen as a consequence. The tendency of many rotary holes to become oblique has led to a careful control of their verticality, or alternatively to special methods of three-dimensional survey wherein the deviation can be carefully checked and placed on record. The great depths of modern drilling and the high pressures encountered have brought new problems to metallurgy to provide equipment and casing which will stand up to the new demands, and great ancillary industries have grown up to cater for the needs of oil production. Engineering problems change from field to field, and include problems of transport, of surface terrain, of drilling under the sea, in swamps, in dense forests or arid deserts, of drilling to depths of two miles and more through formations of every type and character, drilling which must be done speedily and with efficiency if costs are not to become prohibitive. That this has been successfully achieved is a great tribute to the work of oil-field engineers, but they would be the last to claim that this is due to their efforts alone. It is again the result of the same team work but of a different balance in the relative importance of the contributing technicians.

(*c*) *Transport.*

The oil industry is dealing with a crude product and with refined derivatives which may vary very much in their physical character. They may be highly viscous or exceedingly mobile, inert or highly corrosive. They are usually volatile and often highly inflammable. Quite wisely the oil industry has realized that the task of transporting such material is a special one, and it has therefore taken it into its own hands. For transport over the seas it arranges for the building of special fleets of tankers which are among the best examples of the genius of our shipbuilding yards. Overland, the oil is carried in great trunk pipe-lines which may transport it thousands of miles and collect it from innumerable feeders. Transport by rail or by road is provided by thousands of tank cars which are specially designed for the task. The industry has great tank farms, usually constructed of steel but sometimes of earth or concrete, which are necessary to preserve the millions of barrels of its products which must act as a buffer between the producer, the refinery, and the market. In addition to the problems of administration, there are problems of pipe corrosion, of evaporation, and a whole number of other complications which bring the engineer, the physicist, the chemist, and even the biologist into the picture before they can be finally solved.

(*d*) *Refining.*

There is little need here to dwell on the problems of refining, for they have been discussed in all their aspects in the pages of the Institute's *Journal*. There is, however, one point which cannot be stressed too strongly. The modern refinery, with its co-ordinated units, each devoted to particular reactions, fractionation, topping, cracking, alkylation, pyrolysis, isomerization, re-forming, and other processes, gives rise to engineering problems in its construction as numerous as the chemical reactions which take place in the units. Furthermore, without the innumer-

able physical instruments by which these reactions can be followed and controlled the plant could not be operated. Refining is as far removed from the laboratory apparatus of the chemist as a modern steamer is from its working model, and many a chemist who may feel at home in his laboratory finds it difficult to become acclimatized to the new world of a refinery because of the difference in environment. Yet, in spite of all this, the operations which are carried out in these highly specialized plants are basically chemical, following the principles worked out in the laboratory by chemical science. Therefore, though many different sciences contribute to the success of a refinery, the basic principles on which it works lie primarily in the field of the chemist.

It has always seemed to the author that the oil which the geologist and engineer have been at such pains to find and produce is too good to burn. That the same general view seems to be gaining acceptance in the chemical world is a welcome sign of the times. All honour to the men who are delving into its nature, breaking and re-making its constituents into new and more useful substances, and opening a new vista wherein oil bids fair to become the basis of a whole series of new chemical products.

(e) *Marketing.*

The oil industry prides itself on its ability to meet the demands of the consumer. This entails a close contact with those who are using its products, and, as petroleum is not a fixed and uniform material, it requires the development of a large number of standard tests to create standard products. For the efficiency of this testing and marketing trained scientists, in particular chemists, physicists, and engineers, are needed. Their work is mainly carried out near the consuming centres, and an important section of the research laboratories of the industry must always be associated with them. Much of the testing of the special motor fuels is an engineering rather than a chemical problem, and most of us are familiar with the great strides in the improvement of fuels which have taken place as the result of such examination and of the close collaboration between the engineer and chemist in the standardization of new fuels.

Finally, it is an essential pre-requisite for success in each of these sections of the industry that the technicians must be continuously reaching forward to new achievements. The very multiplicity of their problems creates a flexibility of view which is the finest foundation for future progress, and the environment engenders a research outlook which is the key to all advancement.

Education for the Oil Industry.

In the preceding review of the functions of each department of the oil industry it has been reiterated almost *ad nauseam* that in the main oil work is team work, the members of the team belonging generally not to one particular science, but to a wide range of the sciences and engineering subjects. If this claim be accepted, it must also be conceded that the average technician required by the industry must have a broad scientific basis as well as a specialized knowledge in his own particular branch of the subject. If he is to form a successful unit in a team, his fundamental

knowledge in mathematics, physics, and chemistry must be sound. In no other way can he appreciate the value of the contribution which his colleagues can make to his work, and he to theirs. This is a generalization to which there are a few exceptions, but it is a good working hypothesis for the industry as a whole.

One of the major difficulties with which the British oil industry is faced in its recruitment policy is the fact that the principal oil-producing centres are abroad. Refining and marketing do not suffer from this handicap, at least not to the same extent, but the net result of this condition is that there is no corporate community centralized in any part of our Islands which represents the life of the petroleum industry as a whole and could be expected to provide a local population from which recruitment for the industry could draw much of its material. Whatever may be our position in the future, this has been a serious handicap in the past, and on the whole the industry has done remarkably well in spite of it.

Those who have anything to do with recruitment for the staffs of the oil companies realize that the position is by no means easy. The appeal of a life abroad and of a change of environment is not as strong now as it was in the Victorian period. A student can satisfy his desire for adventure in many other ways, and furthermore, the trend of modern inventions has been to bring the conditions of foreign lands so close to us that their romance has worn somewhat thin. A further problem which is very material to the issue is the small size of the average middle class family in England at the present time, and the natural reluctance of parents to see their only son choose a profession which will inevitably lead to his separation from them for long periods. There is, however, no lack of the spirit of adventure in the rising generation, and imbued by the pioneering spirit which has always been part of the oil-man's heritage, new personnel are attracted by a type of work which affords opportunities for satisfying the desire to get out and see more of the world.

Whilst a certain proportion of those who enter the industry may only have reached the higher grades of a secondary school education, and in their case there is need for continuation courses in industry, most of the younger employees, particularly those recruited for foreign service, have received a University education, or at least have passed through a Technical College. Most of them take a University degree, and have specialized in one of the sciences or in one branch of engineering during their College career. In either case unless a University course is designed for the Petroleum Industry—and this is exceptional—there is little reference to petroleum problems during the training, though in most of the sciences a proper University course could not fail to make some reference to the subject.

It must, however, be realized that a normal University course in any of the sciences may suffer if adapted to the needs of a particular industry. It must treat the subject in such a way that a student gets an all-round balanced view of the basic principles of his science and of its general application. Unfortunately many of our sciences have become so unwieldy that even this general balance cannot be fully obtained, and the tendency is for a given subject to become strong in those sections which are of local interest or in which the staff of the College are carrying out research.

There is therefore, even in the Universities, a tendency to emphasize unevenly the different portions of the main subject. In a subject like geology, wherein there is a biological section, *i.e.*, palæontology, and a chemical and mineralogical section, *i.e.*, petrology, the student may take one course or the other up to the Honours standard, after a preliminary training in both. However, in other cases he may have little more than a nodding acquaintance with one of the sections, whilst his knowledge of the other may be exceedingly detailed. The same is in the main true of many of the other sciences, and although the general syllabus may be broad, the student rarely achieves the highest standard in more than a portion of the whole.

Inevitably that in all University courses, once the ground work has been acquired, there is a tendency to specialize in some particular direction. The student never really understands the difference between accepted explanations and the truth until he has chased that elusive goddess in one of the by-ways of his subject only to find her receding ever before him. This is research, and though, put in this form, the prospect may not sound very encouraging, the process teaches a valuable lesson to each and all of us, giving that due respect for the thoroughly proven fact and at the same time a divine inquisitiveness into all else, which is the beginning of true knowledge. Each and all of us faces life with two potential assets. There is what we can learn from others and what we learn by our own exertions. On the whole, what we learn by the latter means is of much greater value to us as individuals because it becomes part of our being. University education, therefore, should always be rounded off by independent study wherein the teacher keeps in the background encouraging and advising, but allowing the student to make his own way. This requires a close understanding between student and teacher without which a University course is a poor meal.

Unless a University is located in some area serving a community which has special industrial needs, it can rarely consider the requirements of any particular industry in its curriculum. However, where it is so located it is both right and proper that a strong bias should be given in its training for the benefit of the local industry. Such a process is inevitable in any case, for the mere fact that there is a strong local demand for trained students and good facilities for their industrial experience is bound to create a bias in favour of a particular type of training. Universities in such areas must, of course, be on their guard lest this training should exclude the legitimate requirements of those students who desire to follow other branches of learning, but the idea that every University should teach universal knowledge is neither true nor is it an attainable ideal.

Although there is no complete cross-section of the oil industry in any part of these Islands, we owe to the acumen of the late Lord Cadman and Professor Watts the inception some 30 years ago of two schools for instruction in petroleum technology, one at Birmingham University and the other at the Royal School of Mines. The author has been associated with the latter practically from its inauguration, and has shaped its courses to fit the changing needs of the industry. As a geologist in a geological school it was necessary to keep in touch with the work of geologists in the oil industry, and the only way to do so effectively was

to become one of them as far as that was possible. It has been a fascinating experience to grow up with the oil industry, to see its problems alter in the last three decades, to face the changing conditions in the industry, and to watch the growth of a British school of oil geologists who have won for themselves an accepted position in the world. At an early stage it became obvious that geologists would find an outlet for their science not only in the direction of exploration, but also in the exploitation of oil-pools, and the problem was to develop a curriculum which would train students to be capable of dealing with either branch of this work. Fortunately most of the subjects required either for exploration or exploitation are in general of a similar nature, and all students would need to be familiar with them. The bias lies primarily in the aptitude of the student either for orthodox geological field methods or for the more physical and mathematical sides of the subject which are associated with the development of an oil-pool.

In any case the course designed for an oil geologist must necessarily include a large number of subjects not normally taken in a University course in geology. Topographical surveying, principles of drilling, the characteristics of drilling muds and oil-field waters, geophysical methods of attack and a number of ancillary subjects, which an oil geologist must study to a considerable extent, even though he need not necessarily master them in detail, are quite foreign to ordinary geological training. On the other hand, a large amount of the stratigraphy of the British Isles which would normally be taught in great detail in any British school of geology has had in the past no direct bearing on the work which an oil geologist has to do. It was obviously better to replace this stratigraphical study of the British Isles by a corresponding study of the stratigraphy and structure of the world's oil-fields. The essential features of such a course are therefore the following :—

(*a*) A thorough groundwork in mathematics, physics, and chemistry.
(*b*) A general course covering the whole field of geology.
(*c*) A more detailed course of physical geology (the philosophy of the subject) and structural geology.
(*d*) Petrology mainly devoted to sediments but including all rock types that a student may have to deal with, and a special palæontological course, in which micropalæontology figures largely.
(*e*) A study of the world's oil-fields.
(*f*) Physical and chemical testing of oils, oil-field waters, and muds.
(*g*) Surveying, the theory of drilling, and geophysics.
(*h*) Field studies and industrial training.

Whilst this synopsis is not exhaustive, it is sufficiently comprehensive to indicate the need for a four years' course if the ground is to be covered thoroughly. (In most of our Universities there is a tendency to demand this longer period, in order to enable a student to pursue his studies in one direction further towards completion.) The ideal to be aimed at is that one of the subjects should be chosen for advanced study which should lead to a period of research wherein the student can have time and leisure to trace a particular line of inquiry to some degree of finality.

Throughout the later part of the course the student should be encouraged

to work from original references in all matters, in order to get a proper appreciation of the value of a library. Concurrently, and preferably as early as possible in the educational process, the student should obtain personal experience in the industry. He need not at this stage be sufficiently advanced to appreciate fully all that he sees, but on the other hand he will get a clear mental picture of the work which he may be required to do, and return to his training with a clear conception of its purpose and an added zest to achieve success. The oil companies as a whole have been exceedingly helpful to us in enabling our students to obtain this industrial experience, and the facilities they have provided have been of immense value to the students, particularly in giving an impetus to their studies.

Realizing fully the fact that it is not possible for a single department to cover the requirements of all sections of the industry, it has been our custom to mould our own students in such a way that their training would be complementary to that of the Birmingham school. In this way it was expected that the two establishments together would help to fill a gap which would otherwise be left in meeting the educational requirements of the Industry, and the author hopes that an authoritative statement will be added to his contribution to cover the Birmingham University courses in Oil Engineering and Refining.

Suggestions for the Development of our Educational System.

In dealing with the courses in Oil Technology at the Royal School of Mines which are designed to meet the needs of our exploration and exploitation geologists, it will have been noted that some of the subjects in the curriculum would not normally appear in a geologist's training. Yet these subjects are essential for an oil geologist, and without them, or at least without a considerable acquaintance with them, he is lost (exclusion must, of course, be made in the case of certain geologists who are specialists). Neither is it reasonable that a student should spend a very large part of his time in the detailed study of the stratigraphy of a particular area the knowledge of which is unlikely to help him in his future work, when the same time could be spent and the same general principles absorbed in the study of regions where oil is found.

Whilst, therefore, the basic foundations of geology are the same everywhere, there is everything to gain and little to lose in making a course for a student in oil geology definitely *ad hoc* to his subject at an early stage. This must not be done at the risk of weakening his general foundations in the science, but there need be no danger of that if it is done properly. Furthermore, oil literature has now become so extensive that a student who enters the industry without having had a long period in which to study it is severely handicapped, and his work afterwards suffers. The author believes that this fact will have to be recognized at an early date if we are to maintain the efficiency of our British oil geologists in relation to those who are being trained elsewhere. No young geologist now entering the oil industry should be weak in mathematics and the fundamental sciences, incapable of carrying out a topographic survey, uninformed on the subject of geophysics, or constitutionally antipathetic

to physical and engineering problems. The only exception to this would be those who are entering for specialized work alone.

The features which apply to the training of oil geologists have their counterpart in each of the other sciences, and certainly from the author's observation the more we can teach our future technicians about the related work of the sciences with which they have to deal, the better will be the results of the common effort. In one direction in particular the industry can help each of the sciences, and thereby improve the education of its employees. Investigations which are carried out in the oil industry are in some cases of such a nature that they cannot be published for a period, but there still exists an unfortunate tendency to deny to technicians the privilege of publication even long after the general results are known within the industry. There is no advantage gained by this secrecy, whereas a timely publication would bring credit to the companies' technicians and to the companies themselves, and would also spread desirable information which would be good for the industry as a whole. The policy of withholding information is the very antithesis of the team spirit which spells general progress. On the whole it usually recoils on those who practise it in retaliatory measures which are not difficult to devise, and in any case the good sense of technicians usually results in the dispersion of the knowledge among their fellow members of the industry, so that it might with equal propriety be published and the full credit given to the right quarters. Of late years the industry as a whole has become more generous in its attitude in these matters, but whilst it cannot be denied that it has every right to safeguard its interests, the safeguard should be in the hands of those who can use it effectively and can use their judgment rather than in a general principle of prohibition. In this particular there is much that can be gained in copying the practice of American oil companies, who usually take a more generous view on the early and wide dissemination of information of general interest to the industry as a whole.

There exists among the general public a very distorted view of the economics of the oil industry and an almost complete ignorance of the work which it is doing. The tendency of the average man in the street is to associate oil companies with vast monopolies which kill competition, make enormous profits and in general have their fingers in all international affairs. He knows nothing of the immense risks that are run in the finding of new oil-fields unless he happens to be an unfortunate shareholder of a derelict company, nor does he realize the need to create large companies if the services which the oil industry carries out for the community are to be properly performed. He knows nothing of the good sense which has attempted to eliminate the evils of competitive drilling while preserving the efficiency of general competition, nor does he realize the smallness of the profit per gallon and the stringent overall efficiency which is necessary if a company is to survive. Yet these are the facts of the industry, and there is no reason why they should not be widely published. There are companies who through good fortune have made handsome profits; but they are counterbalanced by those who have fallen by the way, and the general overall interest on the capital invested is surprisingly low when due regard is taken of the risks involved. The only adequate safeguard against such risks lies in the spreading of a company's

interests over a considerable area of potential production, *i.e.*, it lies in the growth of the individual companies into units which by their very size and the extent of their potential reserves are sure of a continuity of production.

The number of employees at work in the oil industry is exceedingly small in relationship to the total output of oil and to the capital involved. If, furthermore, we exclude the relatively large army of the rank and file in the distributing part of the industry, the figures are still more striking. Like all other industries, marketing appears to involve a greater inefficiency in the use of labour in relationship to the strict requirements, but this condition is more apparent than real, for it is a feature which affects all our industries, and until we have created readjustments throughout the community it is probably unavoidable.

The scientific and engineering staffs in all branches of the industry are highly trained technicians, many of them giving the best part of their lives to work in regions which, no matter how the companies may attempt to improve the environment, cannot be compared with the motherland. In one particular, *i.e.*, the education of the young children born in the tropics, far from the normal educational facilities available in this country, a considerable problem arises. Up to a certain age arrangements can usually be made locally with the co-operation of the companies, and this is generally done, but there comes a time when it is essential that the children should be given a broader education available only in more civilized areas. It seems rather curious that an industry which has taken such care to meet the smallest whims of its customers should not have developed a comprehensive scheme to give the children of its own employees, who should be the oil-men of the future, the best opportunities for a school and finishing education. Such children ought to be excellent material as candidates for future posts in the oil industry, and if taken in hand early enough would go some way towards satisfying the recruiting problem, for if we are to attract the right sort of youth to the industry we must go back to the schools. Would it not therefore be wise to encourage selected schools with bursaries and leaving scholarships as is done by several other industries.

Much good work is being done by many of the oil companies in other directions, and several of them have been exceedingly generous in the awarding of scholarships to Universities. It would be a welcome tribute to the value of the technical staffs of the oil companies if the industry would tackle this educational problem on broad lines, recognizing the fact that if we cannot be collected into one community in this country, we can at least place a general educational service at the disposal of those who give their services unstintingly to the industry they serve.

The most important years in the education of the average individual are those spent at school. There, in the main, habits are formed and the mind in its most plastic form gains its main impressions. Home influence and school life are largely responsible for what we are, though later environments, particularly if they are dominant ones, may affect us considerably. So far as the curricula of the schools are concerned it will usually be found that they are dominated by the public examinations, the School-leaving certificate, matriculation, Higher School certificate, and Intermediate. As

the efficiency of the teaching is normally gauged by the examination results we cannot expect a large measure of attention to be paid to other yard-sticks, nor is the matter helped by the intense competition of scholarship examinations which creates still more concentrated effort along certain rigid and restricted lines.

There is no effective alternative to the general system of examinations, but there can be some safeguards to prevent too early a specialization, too narrow a restriction of the subjects to be studied. The standard reached by many boys at school is exceedingly high and is a tribute to the skill of the teachers and the aptitude and hard work of the serious pupils, but it is sometimes purchased at a price which is not good for the ultimate welfare of the pupils. Specialization can be controlled by the skilful setting of general knowledge papers and a greater emphasis on essays. Among many of our young science students there is a deplorable inability to express their thoughts in presentable English. This is certainly a growing evil. The remedy surely lies in the insistence on a broader basis of general study up to the standard of matriculation, and a departure from the present scramble to take this examination as early as possible in order to begin specialization immediately afterwards. Where scientific courses are ultimately followed they should not be limited to the basic sciences, but should include one science such as botany, zoology, biology, or geology, which are closely related to the world in which we live. No child should go through school without some training in the sciences, and this training should be introduced as a means of teaching observation and deduction. They are as essential in a liberal education as the subjects hallowed by custom.

The argument that the multiplicity of subjects would overburden the pupil's mind is no reply, for what is aimed at is not a more overburdened mind, but one properly adjusted with a sense of values and untrammelled by superfluous detail.

The same applies in general to our education in the Universities. The detailed knowledge of one particular branch of a subject is necessary in the present state of our advancement, but the student should be safeguarded from the effects of such final concentration, firstly by emphasis on the thoroughness of his grounding in the basic sciences, and secondly by a more complete insistence on well chosen ancillary subjects, one or more of which should be included in his curriculum. This principle is subscribed to in most of our University courses, but often the ancillary subjects are poorly chosen and the student regards them as an unfortunate hurdle rather than as a help in his future work. Finally, all University education should make provision for some independent work in the later stages of training to encourage and develop the creative principles of self-reliance and research rather than the mere passive absorption of accumulated facts.

The writer has been careful to avoid indulging in any comments on methods of education because to do so would lead to a discussion which, however fruitful, would not help the present issue. We are not so much dealing with methods of training as with a general educational policy for the good of the industry. Occasionally during the body of the statement one cannot help airing personal views and there are certainly some general

remarks which will probably receive a measure of support. Firstly, with regard to personnel, the condition of a sound mind in a sound body is essential for a recruit into our industry. Oil work, at least that part of it which is spent abroad, requires a robust constitution, and candidates for such work should have a healthy sports record. Secondly, with regard to the mental preparation, the writer has never been able to subscribe to the view that it does not matter what you teach a boy so long as he hates it thoroughly. This may have certain disciplinary significance, and all education should not be made so easy that it is effortless, otherwise the average mind does not become built on those robust lines which glory in the overcoming of difficulties. However, difficulties will arise without their artificial manufacture, and on the whole the more positive method of education wherein the student's interest is aroused so keenly that he pursues his studies through his own volition is definitely the better way. Furthermore, while there is no denying that the choice of curriculum is highly important, it is not "the" vital feature of a good education, which should be the inculcation of a right attitude to life. If we fail to instil this attitude, our educational policy is a failure as a whole, whatever skill we may have taught our students in certain directions. In this sense the actual courses are less important than the traits which they engender, accuracy, neatness, good time-keeping, continuous hard work until the result is achieved, a deep appreciation of the significance of knowledge, and a willingness to impart as well as to receive. Man finds his greatest satisfaction in work well done and in his secret heart would prefer to go down in defeat knowing his work was good rather than accept the plaudits of the uninformed for success which he knows is not merited. There is no royal road to success save by good honest toil, whether it be with the hands or with the head, nor has the manual worker any right to a monopoly of the term "labour," which is as applicable to the student and to the scientist as to any other worker.

All that has been said above about the aims of education can be summed up in the general statement that education is the moulding of behaviour. As such it involves the building of character and the implanting of knowledge. Whilst it is true that our most receptive phase is in youth, the process never ceases through life. It is one of our duties, and a privilege also, that we are all consciously or unconsciously engaged in the process of education. This is not a monopoly of the teacher, though it may be more constantly in his thoughts, but the duty of us all to those who will follow afterwards.

The Educational Work of the Institute.

When our Institute was originally formed, one of the main objects of the Founder Members was stated to be the provision of a better education among petroleum technologists and the accumulation of information on the occurrence, production, and refining of petroleum and oil shale. The stimulating Editorials of our first Editor, Mr. Dalton, returned to this point on several occasions, and in particular in the first volume of the *Journal* you will find he rightly lays emphasis not on the conveyance of information nor on the accumulation of facts, but on the stimulation of

thought, the engendering of the right atmosphere in which ideas will flourish and bear fruit. It is from both these standpoints that the work of the Institute will ultimately be judged.

The *Journal* of the Institute should constitute the main medium for the dissemination of information, and the abstracts should be a valuable means of keeping its members abreast of current literature. The progress reports, taking, as they are meant to do, a bird's-eye view of the developments in particular directions, are possibly of even greater educational value, at least when they are written from this point of view. We do, however, need at longer intervals more comprehensive reviews of the trend of thought and development in the various branches.

The formation of the student sections, the various student awards, and the encouragement given to students in the publication of some of their contributions, many of which incidentally have been very welcome additions to our published knowledge, have all been indications of our great interest in our younger men. I am quite sure that all of us would desire that this side of our activities should increase, for it is in the hands of our younger men that the future growth of the industry lies. Our branch institutions, particularly those in the oil-producing areas, are pillars of strength. Papers from these branches have a great value, for they tend to preserve the balance of the Institute's interest. We must strengthen our ties with our branches and create a greater flow of literature from these potential sources of supply.

There are, however, other tendencies within the Institute, admittedly the result of the fact that our members resident in this country belong dominantly to the refining and marketing branches of the industry, which, if allowed to proceed unchecked, will completely destroy the balance of our representation. The *Journal* is rapidly becoming so dominantly chemical that it is beginning to convey the impression abroad that the membership of the Institute conforms to this tendency. This is actually not the case, for an analysis of existing technical members shows that they are evenly divided between chemical technology on the one hand and exploration and production on the other. If we do not take heed of this warning signal, far from broadening the basis of our membership we are most likely to narrow it ultimately to a section of the industry which, however important and indispensable, does not represent the whole of oil technology. No members desire this to happen, least of all, I believe, those chemist members who would be the residual portion.

A survey of the publications of the *Journal* during three practically equal periods indicates that the proportion of chemical papers has risen from 52 per cent. in the first period to 59 per cent. in the second and 71 per cent. in the last period. This increase of chemical contributions to a dominant position has indeed become still more marked in the last five years, for, apart from 1942, the tendency has been to average about 80 per cent.

That chemical papers should, in fact, tend to predominate is very natural, for it is the experience of all societies that a large number of their contributions arise not spontaneously, but as a result of canvassing by members who are actively interested in the work of the Society, and members living in this country can obviously be more readily approached than those abroad.

Of more ominous significance is the tendency of many geologists and engineers to publish their papers in other journals, indicating that in their considered opinion the *Journal* is not the ideal medium for their thoughts, because it is unlikely to be read by their brother scientists in other branches of their own science. While this continues the *Journal* cannot be regarded as giving an average cross-section either of the industry or its own membership. These are the facts, the results of a set of circumstances which are admittedly difficult because they inevitably give a bias in the very direction which the Institute has taken. They are a natural result of the conditions, and must either be accepted and allowed to take their course, with the consequences already indicated, or they must be resisted and safeguards introduced if we are to preserve our broad basis and keep a more evenly balanced representation of all sections of the industry's activities. It would not be proper to attempt to suggest the necessary safeguards here, but the author would be failing in his duty in a discussion of this type if he failed to direct attention to a feature of this nature which will tend to endanger the educative work of the Institute.

INSTITUTE OF PETROLEUM

A MEETING of the Institute was held at the Royal Society of Arts, John Adam Street, London, W.C. 2, on Thursday, 29th April, 1943, at 5 p.m. MR. C. DALLEY, President, occupied the Chair.

The following paper was read :—

" Education and the Petroleum Industry." By Professor V. C. Illing [Fellow] (see pp. 259–277).

DISCUSSION.

THE PRESIDENT, in opening the discussion, said he would like to confess at once that in his training as an engineer he had always been top of the form in chemistry.

He thought that the men, to whom Professor Illing had referred, who had to see that oil was found, whether by geophysicists or by geologists, so that the people who contributed the money should receive a return on their investment, were men for whom technicians should have every sympathy.

Professor Illing's remarks about the geologist and the geophysicist had made him think of the aptitude of petroleum technologists for adapting to their industry methods which were well known outside. In the last few years the geologist had had a number of useful tools given to him to help him in his task; for instance, the Electrical survey, which was of value in many parts of the oil world and was an application of well-known electrical principles. There were many other methods which he thought should be regarded as weapons for the geologist, who was the man to whom one had to look for finally obtaining oil.

There was a difficulty in connection with publications in the *Journal*. He often had the uncomfortable task of refereeing papers which were going to be read at Engineering Institutions, but which were peculiarly oil papers and should be read before the Institute. The writers were 90 per cent. engineers and only 10 per cent. petroleum technologists, however, so they read their papers to their Engineering Institution. The only way to get them into the *Journal* was for joint meetings to be held of the Institute and the particular Engineering Institution.

MR. T. DEWHURST commented on the interest and excellence of the address, and said that he was glad that Professor Illing had referred to the valuable pioneer work of the late Professor H. de Böckh. A survey of the Egbell (Gbley) area in the Vienna basin was carried out with the Eötvös torsion balance in 1915 and 1916, and indicated the presence of a dome. Oil was discovered in this dome in 1917, and de Böckh was struck with the coincidence and became most enthusiastic in regard to the value and possibilities of the torsion balance as a new weapon in the search for oil. After the first world war, Professor de Böckh visited this country to explain to him (the speaker) the construction and use of the balance, and from this and other early experiences he could confirm that the general adoption of the torsion balance to the search for oil was due very largely to the insight and enthusiasm of Professor de Böckh.

In regard to the subject of education, he had had the experience of interviewing many candidates from many universities, and he had been appalled at the curricula obtaining at some of those universities. It seemed incredible that university authorities should attempt to turn out specialists in one science after giving them a meagre and quite inadequate grounding in the more basic and fundamental sciences. Students had been ruined by their having been allowed to specialize on totally inadequate foundations.

He believed that the best form or method of scientific training ever devised was that organized by the great Professor Huxley at the old Royal College of Science, and it was much to be hoped that Huxley's principles would not tend to become neglected in the present institution and would be much more widely adopted elsewhere.

In regard to the teaching of geology in our universities, he agreed with Professor Illing that there was a tendency to emphasize unduly the importance of the study of igneous rocks and to pay inadequate attention to the very important subject of sediments and sedimentation.

In regard to junior school education, he would point out that in the old days there was a subject called physiography, which included much general elementary science and was a useful introduction to science in general. He regretted that that subject seemed to have disappeared, and suggested that its reintroduction into junior schools would be beneficial.

With reference to the publication of geological papers, the *Bulletin of the American Association of Petroleum Geologists* showed what could be achieved in this respect. However, the American was not so reserved as the Englishman, was more addicted to the method of trial and error, and was keener on new ideas and their ventilation. This attitude of keenness rather than caution was favourable to publication, and consequently when one American geologist got on the scent of a new idea or a new device he was followed immediately by hundreds of others, with the result that there was an enormous output of papers on one and the same subject. That could not occur in connection with the *Journal* of the Institute, as British geologists and engineers were relatively very few in number, and were scattered in all parts of the world. With few specialists and a wide dispersal of interests, it was impossible to secure the degree of intensification that obtained in the United States, where enormous numbers of specialists concentrated their attention on the prospecting and oilfield problems of their own country. Nevertheless, much more could and should be done to encourage publication of geological and engineering papers in the *Journal* of the Institute.

He had been impressed by Professor Illing's remarks as to the importance of obtaining and maintaining a proper balance between the various interests in the Institute. In this connection it should be borne in mind that there were many petroleum chemists in this country, while most of the engineers and geologists were stationed abroad. Some ten years ago he had been impressed with a similar but less striking lack of proportional representation of interests, and he could claim that he had attempted to correct the position by the initiation of a series of Summer Meetings of the Institute. These meetings were designedly held during the season of the year when petroleum technologists who were engaged on oilfields and in refineries in many parts of the world spent their home leave in this country. His view had been that it would be advantageous for home and overseas members to meet and discuss all kinds of technical subjects, and also to meet socially at an Institute dinner. His expectations were amply fulfilled, for the Summer Meetings of 1934 and 1935 were most successful, and were much appreciated by all participants from home and overseas. They also stimulated the Branches of the Institute, and indeed led to the formation of the Burma Branch. He did not know why the practice of holding Summer Meetings of the Institute had been abandoned, but he would urge those who were interested in the subject to look up the old numbers of the *Journal* in which those meetings were reported, when they would realize how beneficial and even inspiring they had been, and would accept the proposition that their resumption after the war would help to smooth out some of the difficulties set out by Professor Illing, and would add to the usefulness, welfare, and success of the Institute.

COLONEL L. V. W. CLARK thought that what Professor Illing had said in his address was absolutely fundamental, but there were a few other points which ought to be considered.

He had had the pleasure recently of dealing with university bursaries for engineers, physicists, mathematicians, and so on, which had been started by a Committee on which he sat and which it was hoped to continue after the war, but it would be very difficult to place the holders of those bursaries in industry after the war. Very large numbers of engineers were being trained, but very few oil engineers, owing to the war situation. It would be very difficult to place those engineers in any sort of industry, and the oil industry would not be able to take large numbers. It would not be possible to increase the educational facilities for oil, because of the small numbers coming forward. He thought he was right in saying that outside Birmingham there was no university in the Empire which dealt with the engineering side of the industry as a full subject. At Birmingham if the number reached five in the final year they

thought themselves fortunate, but it was difficult to place even five coming from one university.

Another point which Professor Illing had made was that teaching was a question of giving. He thought there was one point which ought to be stressed in that connection. If a university lecturer was paid £300 a year to start with and the students he trained were offered positions abroad at £400 or £500 a year, it would be difficult to get any first-class oil engineer to go into the teaching profession. As Birmingham was the only school of its kind in the Empire, any teacher who went into that school had only one opportunity of getting into the top rank, yet he was turning out young men of 21 and 22 years of age who could go out into industry and earn very much more than he did.

Professor Illing had made a distinction between the scientist and the engineer. He wondered why Professor Illing did that.

Mr. J. S. Jackson said he was sorry that Professor Illing had felt constrained to curtail his address in order to keep it within the usual hour, as he would certainly have liked to have heard more of this very interesting paper.

In connection with the broad problem of education, he would like to see a clear distinction made between general education and specialized technical training. He felt that much of the discussion on the present occasion had dealt with specialized training and not with general education. The specialized training of an educated man was a relatively simple matter, but the general education, which was the foundation upon which specialized training was built, presented many difficulties.

He would particularly like to say a word about the teachers, an aspect of the education problem to which reference is seldom made. Colonel Clark had pointed a very obvious moral when he reminded the meeting that the teacher usually earned a pittance while he prepared his students for posts in which they would immediately obtain adequate remuneration. It was indeed not at all surprising that many able teachers decided to follow the example of their students and seek the more remunerative posts, to the lasting detriment of education in general. The teaching profession was after all the basic essential of any educational system. There could not possibly be a satisfactory and effective educational system as we know it, no matter how grand the buildings and equipment of schools and universities might be, unless there was a proficient, enthusiastic, and satisfied teaching profession. He would suggest that the attitude of the authorities concerned towards the teaching profession as a whole epitomized their attitude towards education. If they thought little of the teaching profession they really thought little of education. He submitted that the general attitude towards teachers was rather poor. The "captain of industry," and even the humblest clerk in industry, both seemed to despise the teacher, looking upon him almost as a lower form of life. In fact the teacher was frequently regarded by such people as one of nature's mistakes, something half man and half woman. He felt that such a state of affairs would have to be completely and radically altered, and until the general status and remuneration of the teaching profession were substantially raised and until the teaching profession could attract and retain its fair share of first-class men, all attempts to remodel and improve our educational system were foredoomed to failure.

It was to be hoped that in the not too distant future all children would remain at school until the age of 16, when all who would benefit by further education could, if they wished, proceed to a technical college or a university. If a scholar proceeded to a university, he should then specialize to a certain extent, and the education, while still being quite broad and generous, would lead to some recognized qualification. This could be done by the age of 20. If the student completed his degree at this age, that would be the right time for him to begin to specialize for some particular industry. For instance, the specialized training for the petroleum industry could start then, and occupy two or three years, during which time he could do research or study the technique of the specialized processes involved.

Such a scheme would, however, only cater for the requirements of highly specialized technical experts, and there would still have to be available the means of training the various other staff grades. He said that a good deal of staff training had been carried out in the past by individual companies, but usually in difficult circumstances, since any one company would usually experience some difficulty in collecting the necessary

teaching staff and suitable specialized equipment. Perhaps the universities, and even the Institute of Petroleum, might do something to help by co-operating with the individual companies, and more might be done to provide suitable courses of lectures at convenient centres. Here mention should be made of the excellent work done by the Sir John Cass Institute.

In the past the educational efforts of the Institute had been very spasmodic. The educational value of the *Journal* had been referred to in very complimentary terms, but he thought that the educational value of the *Journal* in its present form was distinctly limited. Normally, the *Journal* was only of interest to specialists, and he thought that something much more systematic could be attempted by way of general education. As a beginning perhaps part of the *Journal* could be set aside regularly to provide matter of real educational value to the normal person engaged in the petroleum industry.

Mr. C. D. Butler said that, speaking as one of those beings just referred to, half man and half woman, who spent most of their lives trying to teach, he thought the teaching profession was, rightly to some extent, looked down upon as being a collection of the good boys of the school.

As a matter of fact, the trouble which he and his colleagues experienced was in trying to find out what the industrialists really wanted. When he buttonholed them one at a time, he found that they did not know whether or not they wanted a brilliant honours student from a university. Very often he was told that it was a disadvantage when one went into a job to be too brilliant an honours student, because the practical man on the job did not like it. Some industrialists wanted students to go through their own laboratories or shops, and said that they could pick up their technical training and their cultural education on the way. Anyone who had had experience of trying to study either technical or cultural subjects at night after a long day's work knew that it was a very great strain to reach a satisfactory technical or cultural standard in that way. A man who obtained a degree or other qualification by night-school work ought to have three stars after his name. It seemed to him that the petroleum industry should make up its mind how it wanted to recruit people. Probably most of those present that evening had got into the industry almost by accident. He thought the industry should arrange some kind of bursary scheme. There were many men who could not possibly stand the financial strain of going to the university without a job in view, but bursaries were an enormous assistance. When boys of 16 to 18, having had a good secondary education, came to consider what profession they should adopt, it should be possible to say to them: "Well, there is the oil industry. If you get into touch with such and such a firm or institution they may offer you a job now, with certain facilities for final qualification, or they will keep an eye on you until you get your degree, and then they will try you out." At present there was little or nothing of that kind at all. The only way in which teachers could keep in contact with the industry was very spasmodic, through old students or personal friends who were actually in the industry. He thought that, to use an oil metaphor, the petroleum industry at present was drawing its recruits entirely from surface seepages, and most of those were probably rather viscous, and very often contaminated. Those who passed through the filtering sands of a university department such as Professor Illing's might emerge crystal clear, but such desirable surface seepages were rare. The industry must explore deeper horizons. For every man who went into the industry now by chance there were at least half a dozen potentially first-class executives or technicians who never got within striking distance of it, because the way was not reasonably clear to them.

Mr. E. A. Evans said that Professor Illing had stressed one aspect which had not been mentioned in the discussion. In brief, it could be described simply as "personality." Obviously knowledge was an essential acquisition, but if it existed without personality the possessor of it was under a great disadvantage. Doubtless we all realized this very simple fact, but it was so often overlooked that its importance was worth emphasizing. Many a brilliant student had failed to obtain a job, or to make worldly progress, merely because his personality had not been sufficiently developed.

It was well to look to some of the other professions where personality must count. In medicine much had been achieved by the doctor creating an atmosphere around the

patient, and in law the ability to convince by sheer personality was a great acquisition. Why not in science? The scientist could continue to make his discoveries, but if they were to become great discoveries it was becoming more and more important that he should be able to convince those around him and the world of their importance.

Personality was not a thing which could be taught; it could only be developed. The art of good description and choice of words could be taught, and should form a very definite part of one's training. It might be useful to quote the old Latin proverb, "He who knows and can't express is just as if he didn't know."

Professor Illing referred to the status of academic men. Generally speaking, most of them were retiring, perhaps somewhat disinterested in everyday worldly affairs. Probably they would claim a much greater market value if they were differently constructed. The absent-minded professor was an unfortunate piece of humour, and was often a pose. The professorial class would probably confer greater benefits on humanity if they pushed the veil aside and exposed the value of their work, and took a more paternal interest in their students, both during and after the training period. There was insufficient intercourse between these learned gentlemen and the rank and file at technical meetings, and finally there could be, and should be, better bonding between industry and science by an increased sympathy on the one side and personality on the other.

Professor Illing, in replying to the discussion, said he was very glad that Mr. Dewhurst had referred to Professor de Böckh's work. He was sure all the geologists of the Institute appreciated that work and its significance.

In his paper there were references to two other outstanding men in the industry. One was Lord Cadman, the founder of the Birmingham School, and the other was his own revered leader, Professor Watts, who had been a member of the Council of the Institute, and who, as early as the time of the foundation of the Birmingham School, realized the importance of geology to the oil industry. In 1912 Professor Watts visited him at Cambridge and asked him to come to the Royal School of Mines and start an oil course there. That was before the Institute was founded, and he did not think there had been a proper appreciation of Professor Watts' work in the *Journal*.

He could assure Mr. Dewhurst that Huxley's method would be continued at the Imperial College of Science and Technology; the authorities there valued highly the system developed by Huxley, and were building on it to meet modern needs.

With regard to physiography, unfortunately that subject had been merged in geography, and had not gained by being so merged. As in the case of physical geology, the geographers had absorbed, but they were not competent to teach physical geography or physical geology. He hoped that the subject of physiography would be resuscitated and put back into the school curriculum with a proper geological course.

With reference to the American Association of Petroleum Geologists and their papers, he agreed that numerous papers were published as a result of a large number of geologists following up a new idea, but, in the main the type of papers printed in journals owed much to the activities of members of the Council of an organization and of members who were keen on particular subjects.

Mr. Jackson had put his finger unerringly on one of the fundamental problems of education. As a nation, if we are to rise to greater heights we must adopt a more generous attitude towards the teaching profession. All attempts to improve our education by Act of Parliament would fail unless steps were taken to raise the status of the teacher, and thereby attract the right types into the profession. It was regrettable that the proportion of male teachers in the elementary schools was so low, for boys needed the guiding hand of men once they had reached a certain age.

Oil companies were maintaining contact with Universities and were attempting to guide students into the industry by giving scholarships and opportunities for practical experience. This, however, was not enough; it was essential that some of the staff of the Universities should maintain continuous contact with the changing needs of the industry. The speaker had felt it his duty to his own post in the University of London to keep one foot in his College and the other in the oil industry.

The speaker felt that Mr. Evans had misunderstood him. His emphasis was on character rather than on personality. The concern of the teacher was to see that

the student adopted the right attitude to his work and to his fellows. Mr. Evans seemed to have been unfortunate in his contacts with the professorial class, and he would like to assure him that there were many who did not conform to his description.

On the motion of the President, a vote of thanks was accorded to Professor Illing, and the meeting then terminated.

THE INSTITUTE OF PETROLEUM.

LUNCHEON.

WEDNESDAY, 23RD JUNE, 1943.

A Luncheon of the Institute of Petroleum was held on Wednesday, 23rd June, 1943, at the Connaught Rooms, Great Queen Street, London, W.C.2. The PRESIDENT (MR. C. DALLEY) presided, and those present included :—

The Rt. Hon. Geoffrey Lloyd (Chairman of the Oil Control Board), Brigadier Sir Donald Banks, K.C.B., Hon. M. R. Bridgeman, Sir William B. Brown, K.C.B., Mr. R. A. Carder, Mr. H. B. Heath Eves, Professor C. L. Fortescue, Sir Frederick Godber, Mr. F. A. Greene, Mr. S. Harlow, Sir Harold Hartley, C.B.E., Mr. A. C. Hearn, Mr. J. Allan Howe, Mr. A. L. McColl, Col. H. E. Medlicott, D.S.O., Rear-Admiral F. H. Pegram, C.B., Mr. W. M. Selvey, The Right Hon. Lord Sempill, Mr. D. A. Shepard, Sir Frank E. Smith, K.C.B., Mr. E. E. Soubry, Mr. F. C. Starling, C.B.E., Lt.-Col. R. A. Thomas, C.B.E., Engr. Vice-Admiral Sir F. R. G. Turner, K.C.B., Mr. E. S. Wood, Paymaster Captain L. A. Boutwood, R.N., Lt.-Col. S. J. M. Auld, O.B.E., and Mr. T. Dewhurst.

After the loyal Toast had been honoured, SIR FREDERICK GODBER proposed the Toast of

"HIS MAJESTY'S MINISTERS."

SIR FREDERICK GODBER said :

I have been given a pleasant and, in some respects, an easy task in proposing this Toast. There is one name that stands out above all others, and the man who bears that name typifies all that is good in our people. His fighting qualities sustained us during the dark days of 1940 and 1941, and his statesmanlike review of the war, when he refused to give us optimistic promises as to the early outcome of the war, was a summing up of the tempo of the people and was almost uncanny. He knew without a shadow of doubt, at a moment when others had very grave doubts, that there could be only one outcome to this conflict. He knew, and saw very clearly, that the people were behind him, and that come what may and whatever be the cost, they would stand solidly with him. He saw this very clearly, and perhaps very much more clearly than many others did. He also saw that the freedom which was obtained at Runnymede had passed beyond the confines of the Empire, and that sooner or later, regardless of what the people and the Empire could do, others would have to stand, and would naturally stand, with us and come into the conflict on our side. He proved to be abundantly right in that. He himself has told us how much we owed to the few—and how very right he was. But never let us forget the duty that we owe to him for what he has done and for what he is doing (loud applause). Let us give him our gratitude and our heartfelt thanks. God grant that he may be with us for many years not only to lead us in war, but also to lead us in peace (hear, hear).

In welcoming the Rt. Hon. Geoffrey Lloyd, Chairman of the Oil Control Board, I should like first sincerely to congratulate him on his appointment by His Majesty to the Privy Council. It is an honour unique and well deserved, and I feel that in honouring Mr. Geoffrey Lloyd, His Majesty has also honoured the industry which we all serve. It has been my lot to see a great deal of Mr. Geoffrey Lloyd during the war, and much of the success with which petroleum problems have been faced and met have been in no small measure due to him. It is also in no small measure due to his very

wise action in securing the co-operation of the industry and in making the industry work with him and for the Government. In the early days of the war, when plans for supplying this country and the Empire with petroleum products were under discussion, he made only one condition, and that was that policy was necessarily a Government matter, but the carrying out of the policy should be left very largely to the industry, and in fact the industry is carrying out policy. Indeed, who could better carry out that policy than those who had spent a lifetime in developing what was an involved and very delicate machine. As an industry we should register satisfaction that on the whole our relations with His Majesty's Government and the Ministry have been in happy accord. I hope that this augurs well for the future. I believe that deep down in their hearts Britons want to be left alone and to leave others alone. All of them long for the day when control will be eased and freedom regained (hear, hear), but it will necessarily be freedom tempered with discipline.

It has been my pleasure recently to form one of a small Mission to Washington. Mr. Lloyd was Chairman of that Mission, and there was an incident in connection with that Mission which I think is interesting because it impressed me tremendously at the time. Among other functions, the Mission were invited to meet the American Petroleum War Council, which was a Council consisting of all the heads of the American industry—some 100 or 120. They represented the senior executive of the whole American oil industry, and Mr. Geoffrey Lloyd was invited to address the gathering. It was not an easy task. He was facing 100 or 120 of America's leading oil men, and after making his speech he, rather incautiously it was felt by some people, invited questions. These past-masters in the art plied him with questions, and he very successfully answered them all. After the Conference it was asked, "Where did that young man learn his oil?" (laughter). That was no mean compliment from these hard-headed oil men to pay to the Chairman of the British Oil Control Board.

I am sure I am speaking for everybody present, as I do for myself, when I wish Mr. Geoffrey Lloyd every success and assure him that all the practical knowledge and experience of the industry and especially scientific knowledge, are at his disposal and express the hope that the industry will be enabled to place at his disposal the experience and knowledge in peace as well as in war.

THE RT. HON. GEOFFREY LLOYD (Chairman of the Oil Control Board), in replying to the Toast, said:

It is a great pleasure to be here once again at the annual luncheon of the Institute of Petroleum because, after all, I have had the good fortune, not entirely common among Ministers, of having done the same job since the beginning of the war. Although I was very much of a neophyte and a beginner the first time I came to this luncheon, now, after nearly four years, I can see many people with whom I have not only worked closely during the war, but for whom I have a great respect and whom I regard as my personal friends. I can see a great many in this hall to-day. The fact that not only have I done that part of the job that has fallen to me here, but have also, as Sir Frederick said, been through my baptism of fire in the American oil industry, leads me to hope that, although I make no claim to be an oil man in the full sense, if I am granted the privilege of going on for a few more years I may even graduate to the rank of being regarded, perhaps, as an honorary oil man (laughter).

I only want to say, in reply to the Toast that Sir Frederick has given in such nice terms, a few general words about the oil position and the oil organization in this country during the war, because not very much has been said about it, for reasons which I shall come to a little later on. A great Allied war leader has said that this is a war of engines and octanes, and that is, in my view, a very highly specialized application of the wider truth that the present war is fundamentally based on oil and oil-driven engines operating by land, sea, and air. Thus it is that the quantity and quality of petroleum products available for the fighting forces and for the supply systems that support them are of vital importance to war potential and war strategy. Of course, for that reason, oil being so close to the fundamental strategy of the war, it has, during war-time, to be shrouded in a proper secrecy. Therefore, we cannot talk about most of the things which most of you in this room are engaged on at the present time, and have been engaged on during most of the war. In fact, I doubt whether there could be gathered together in a room of this size a number of people who, when you consider

the ramifications of oil in war, know more of the inner secrets of this war than some of you people here.

But there is one subject on which it is possible to say certain broad things, and that is that the production of high-grade aviation spirit does constitute a triumph of research and development for the men who have done the jobs in the secrecy of the laboratories of England and America. Without going into technicalities, which you know far better than I do, it is the fact that better aviation petrol enables the fighter aircraft to make those sudden bursts at the highest speed. It also enables bombers to take off with the heaviest loads, as well as, of course, increasing the range of both types of aircraft. That is just as important in the battle of the Ruhr as it was in the Battle of Britain and the Battle of Malta.

Having said just a word about quality and the effect of quality of petroleum products on war operations on the Allied side, perhaps I might say one word about the effect of a deficiency in quantity as it has manifested itself and has shown itself on the side of our enemies. It was indicated in a recent broadcast by a German officer of the Afrika Korps when he said, "The question of petrol harries our nerves . . . we have to remain on the roads because a diversionary route through the desert would use up too much petrol . . . a large number of petrol containers washed up from a sunk ship helps the retreating forces for another short spell . . . the supply situation becomes more and more difficult . . . there is no petrol with which to transfer troops."

I do not need to add any comment to what that German officer said, except that on our side it is the fact that throughout the war sufficient bulk supplies of petroleum products have been available for the operations of British forces in all theatres of war throughout the world (loud applause). That achievement would never have been possible without the wonderful work that has been done by the Petroleum Board and the oil industry generally, both in this country and in the United States, because never forget that in addition to our own resources we had great assistance from the great oil companies of America long before America even came into the war on our side. On my own account I would like to agree with what Sir Frederick said about the co-operation of the industry with the Government during the war. As he said, it is for the Government, who know all the strategical factors and have official information with regard to the war, to lay down policy, and I think we were right to bring the industry in and ask them to do the actual executive work, which they know so well how to do. I think it is of interest to draw your attention to the pronouncement made recently on the subject by the Select Committee on National Expenditure. If I may say so, that is not a body that distributes bouquets in all directions, but they have said that the arrangements between the Government and the industry were to be commended as being clear-cut and simple and functioning satisfactorily. I think that is a tribute that we can all feel very pleased to have.

You know better than I—although I am now beginning to know a certain amount—the tremendous ramifications of the work that is being done by those who are engaged in all aspects of petroleum supply and production, but inevitably, as I have said, there is a common secrecy shrouding all this work during the war, but I would like to take this opportunity of giving a message from the British Government to all those who are working in this great field to-day. That message is that the British Government realize that all of them are doing a vital war job which is for the most part highly secret, and we ask you to continue your great effort in the knowledge that your contribution will be able to be made known when it is possible to tell the full story when the victory is won (loud applause).

"The Institute of Petroleum."

Mr. A. C. Hearn :—

I endeavoured to persuade one of the eminent naval officers present to propose this Toast, as seemed fitting in the fourth year of a war in which the petroleum expert had played so valuable a part in and behind the fighting line. I was baffled, however, by reference to the Silence of the Senior Service and to the limitations of the (so-called) Simple Sailor. I feel bound to say that, in a long experience, I have noticed no incapacity amongst naval officers to express their feelings, with both vigour and fluency, when the need arose. As had once been very pertinently asked, how other-

wise did the sailors' parrots manage to get their stuff? As regards their alleged simplicity, it is only to be hoped that our diplomats are blessed with a similar form of guilelessness!

I must apologize for this digression, but I number so many friends amongst its members that although the Toast is strictly proposed to the Institute—a corporate body—I feel that it is really addressed to the individuals composing it; that is, to its molecular constituents. The mention of molecules reminds me of a sentimentalist who, reading of many forms of violence and maltreatment applied by modern chemists and engineers to the hydrocarbon molecule, came to the conclusion that they must be a singularly brutal lot of people. He supported his novel thesis by claiming that they, in conspiracy with the engine designers, had made modern warfare the catastrophic affair it had become. Unfortunately, and quite unavoidably, in so many ways and in so many lands, war and peace make complementary demands on the science and ingenuity of you all. Far from worrying about the criminal charge, you can pride yourselves on having contributed so much to the victory that is now inevitable.

Although I have retired from active participation in the industry, I still see the Institute's *Journal* and various other technical publications. I am greatly impressed by the scientific approach that is being made in all quarters and to all types of technical oil problems. I can remember, years ago, listening with amusement to informal discussions between geologists and chemists in which the main question at issue was who represented pure science and who that impure thing known as empiricism? The impression then left on my mind was that few of them were scientists and none of them was pure? Those days are now happily past, and it seems to me that nowadays we are all scientists and all pure! I am incompetent to say in which direction most progress has been made, but personally I have been particularly impressed by what is being done in the chemical world. This, however, is largely due to the imposing and complex nature of the formulæ in which the chemists indulged, reinforced as it is by the sesquipedalian abracadabra of their written and spoken language. It is awe-inspiring, and, I feel, slightly infectious.

I should like to emphasize the fact that the many exacting demands made during the war period on the members of the Institute, and on the members of their confraternity in the U.S.A., will be followed by almost equally exacting, though less sanguinary, demands when you again face the tasks of peace. I have no doubt that you will be equal to it.

In conclusion, I should like to say that Mr. Dalley, the President—an old friend of mine and a bulwark of the Institute—is known to you all not only as a technologist who had made valuable contributions to the field and other engineering technique, but also as a very kindly and genial personality.

I now have great pleasure in proposing the Toast of "The Institute of Petroleum," coupled with the name of the President—Mr. Dalley.

MR. C. DALLEY (President), in replying to the Toast, said:

I thank Mr. Hearn for the kind things he has said about the Institute, and also for the personal references to myself, which I value very highly.

It is the custom on these occasions to give a review of the activities of the Institute during the intervening period between these meetings. The first point I should like to make is that it is about thirty years ago that I deserted my first love and joined the petroleum industry. During that period I have been privileged to gain experience in every branch of the petroleum industry and, what is more important, I have had contact with and knowledge of the personnel operating in these branches. Through other associations also I have broadened my contact with those whom I now number amongst my colleagues and friends, and in my present position I can say that the great majority of the members of the Institute are doing their utmost in the war effort for the United Nations. There are also very many others throughout the oil world generally who are 100 per cent. engaged in the war effort on the side of the Allies. There are a few who may feel they could do more, but they must rest content that what they are doing is probably relieving someone who would otherwise be very much overloaded. There would have been many more present at this meeting if they could have got away from their duties, but all those members are present in spirit.

Broadly speaking, for many engaged on production and refining, war-time work is

merely intensified peace-time work, handicapped by shortage of materials, and with the loss of facilities which are readily available in peace-time.

A second point I should like to make—and it is one which has not been appreciated in the past, although it is just beginning to be appreciated—is the great collaboration and co-operation there has been for some time between American and British petroleum technologists. In the past, the average Briton spoke of his American cousin, as of someone distantly removed, yet at that time petroleum technologists in both countries were working closer than brothers in a co-operative effort to solve the problems constantly arising in the industry, and they did so with very great success. There are, of course, many things in common between the two countries—for example, their languages are very similar. There is a section of the Institute in the United States. By comparison it is not large in numbers, but what it lacks in quantity it makes up for in quality. For example, one of the principal members is Dr. Gustav Egloff, who has spent a lifetime in research and is well known for his work in producing high-octane spirit. The Institute has many Branches, and it is usual to exchange greetings with them on occasions like this, but in the case of one Branch we have an advantage on the present occasion and, without encroaching on Col. Auld's prerogative, in proposing the Toast of the Guests, I should like to welcome Mr. Ruthven Murray from Trinidad. He is a worthy representative of one of the most virile Branches in the Institute. It can be still said that Trinidad is the largest actual producer of oil in the British Empire.

The Past-Presidents may be considered as the House of Lords of the Institute and I must speak in an appropriate manner with regard to them as, incidentally, they recommend the appointment of the President! In their wisdom they decided that the Institute should end its period of hibernation at Birmingham and return to London. That has been done, and the Institute is now lodged in the Imperial College of Science. We look forward with hope and ambition to having a building of our own. The last time this matter was discussed, there were no sites in London, but now there are plenty of sites and fewer buildings!

Another recommendation of the Past-Presidents was the appointment of a Joint Honorary Secretary, and they suggested Mr. Ashley Carter (a very popular choice), who, although he was getting older in years perhaps, was getting younger in energy and spirit. He is now busily employed in bringing the activities of the Institute back out of the period of hibernation. The Institute is now holding its monthly meetings again, and there has recently been published a new Edition of its *Standard Methods of Test*. That this is useful is shown by the fact that 1000 copies were sold in less than as many hours, and that should be so when it is realized that the Committees which produced this book consisted of 140 members, all of whom were experts in their particular subject. They were controlled by Dr.—now Professor—Garner, and if ever he needed a monument there is one in this book.

Another important development is the establishment in South America of the South American Institute of Petroleum, embracing representatives of all the Republics in South America. This Institute has been invited, and had freely offered its co-operation. There is a nucleus of British, American, and Allied oil men in all the South American States who can assist in the formation of this Institution and this new body will be of great value to all when properly organized.

One other activity to which I would like to refer is that, model regulations for the installation of electricity in fields, refineries, bunkering stations, and depots, readily adaptable to tropical, temperate, and Arctic conditions, are in course of completion. These new regulations incorporate, where possible, established rules of recognized authorities, and they have been prepared by and on the experience of electrical engineers of the major oil companies on both sides of the Atlantic. Before the new regulations are issued they will have the approval of the relative authorities. I have played some small part in its development, and therefore may be excused for saying that when this book is published it will be unique.

Some years ago the Council changed the name from the Institution of Petroleum Technology to the Institute of Petroleum. The reason given was that it would broaden the scope of the Institute and would bring more people in the industry within its orbit. Personally I do not think that was the real reason; it was rather that the members had a feeling that the petroleum technologist was considered by those outside the industry to be a kind of scientific polygamist! This is merely an incorrect interpretation of his versatility in the immediate adaptation to his own problems of any

new scientific discovery, and one or two examples might be mentioned. Firstly, there is the search for petroleum in which great progress has been made in the past few years. The sub-soil can be electrically analysed to locate gases peculiar to petroleum. A bore-hole 10,000–12,000 feet in depth can be surveyed electrically and a graphic record produced showing where there are oil-sands, where there are water-sands, and whether these are salt or fresh. Their depth can be measured to an inch. There is also the electrical inclinometer which graphically records and correctly orientates the deviation of the hole from the desired direction. Thus the risk of failure to find oil is greatly reduced.

Secondly, in refining plants theoretically all heat used in splitting up the oil is recoverable by interchange, and the oil refiner has nearly succeeded in doing this. Only the other evening, at one of their monthly meetings, a designer of plant complained that the oil refiner wanted all the products and left him nothing with which to fuel the plant!

Thirdly, with regard to products, many will remember that some years ago the coal industry issued a very interesting map showing an oak tree, the trunk representing coal, and the leaves and branches the various products obtainable from coal. The petroleum tree at that time was a mere sapling. That oak tree must have grown considerably since then to represent the additional products from coal. There are still more to come, in the form of oil products.

As to the position to-day, in the April *Journal* of the Institute a paper was published by Dr. Egloff in which he concluded by referring to the solvents, plastics, high explosives, acetylene, synthetic rubber, lubricating oils, aviation gasoline, and edible fats which could be produced from natural gas. As a matter of fact, he states that "if one starts with natural gas alone all the known synthetic products that man has produced in organic chemistry can be derived, and there are over 500,000 different ones. Any synthetic product desired can be produced at a price. The hydrocarbons are all potentially available to be converted into the manifold products that man required in a modern world." Thus, the petroleum sapling has now grown into a forest. But perhaps I had better not pursue this further, or we might be asked by the British or American Governments to submit forms in quintuplicate giving particulars of these different products—*i.e.*, those which they had not had already!

Reverting to my previous reference to the fact that the petroleum technologist is always ready to adapt to his own problems any new discovery, the petroleum technologist is also not averse to looking back into history. Therefore, as it is not permissible now to talk much about what is being done to-day, we might look into history for a moment. When the many products I have mentioned, and the development work that has been done during the last few years, are borne in mind, there may be a tendency to forget that petroleum was used as a munition of war by the ancients. In the Book of Judges it was described how one, General Gideon, went out to smite the Midianites. He started with an Army of about 30,000, but a great number of them went "all-Italian like," and he had seriously to think out some method of carrying out his plan with much depleted forces. He formed a band of Commandos, and armed the men with a trumpet in one hand and a long-necked earthenware bottle containing a lighted lamp in the other. At the proper time the signal was given and the Commandos blew their trumpets and made such a raucous noise that they frightened the Midianites into a state of paralysed immobility. Then they threw the bottles, breaking the necks, and the lamps in the bottles ignited a "secret fire." The noise of the exploding bottles and splinters flying about scared those of the enemy still left alive and they took to flight. Those bottles were used to-day, and were known as Molotoff cocktails (laughter). Whether there is any connection between the cocktail as a drink and the selection of the Commandos, it is clear that the Commandos were selected not for their drinking habits, but for their habit of drinking. Those who are interested and would like to check up this story, should refer to Chapter 7 of the Book of Judges, verses 16 onwards.

I said at the beginning of my remarks that many of those engaged in the oil industry are, in war-time, carrying on their peace-time work of petroleum production on an intensified scale, but under many handicaps. They are an unseen service supplying the other services with their petroleum requirements—a mighty weapon—and they are proud of the part they are playing in the provision of one of, if not the greatest, munitions of war. Petroleum is a powerful weapon of war, but it could also be a greater instrument for peace. It has entered into the national life and certainly into

the national Budget of all nations, whether producers or consumers. Although some people—they could not be oil men because oil men are always optimistic !—seem to think that the petroleum era is to be short, I myself disagree and believe that for a very long time it will continue a controlling factor in national life. When hostilities cease, the oil industry will take a greater pride in the part it can then play in the utilization of this, one of Nature's greatest gifts to mankind, not only in the establishment of peace but in the maintenance of a permanent peace.

"The Guests."

Lt.-Col. S. J. M. Auld (Past-President) said :

It is a practice to be commended that in addition to the more formal speeches at these functions, opportunity is taken to say "hullo" to those friends of the Institute who come to support the Members on their annual festal occasion. It is, of course, impossible to mention all of them by name, but there are a few who will have to be prepared for special attention. First and foremost are our American friends, whom we are so glad to see present in fair numbers—and when I say "friends" I do not mean merely Allies, I mean friends whom no one would ever forget for the manner in which, in our blackest hours, they rallied to our aid and supported us with their sympathy and supplies, money and munitions, and, not the least, with oil. We shall always remember these things. I had hoped to refer this personally to one whose faith in us has never faltered and who worked unceasingly to help us with the supply of the oil which has been our life-blood. I refer to Mr. Orville Harden, who unfortunately at the last moment has not been able to attend, but I ask Mr. Emile Soubry, on his behalf, to accept our gratitude and take back the thanks of the rank and file of the British Petroleum Industry to their own associates in the great American Petroleum Industry, which, throughout the war, has vitalized us by its continuous transfusion of oil. After what I have said I could not suspect Mr. Harden of being an "Indian giver," though the retention of Mr. Soubry in the States might point that way. However, if Mr. Soubry were as often in England when stationed in America as he is in America when stationed in England, we need not grumble.

There is another American to whom I feel sure all would like me to make reference. Mr. Dave Shepard has so endeared himself to everybody who has to work with him here that public acknowledgment of the fact seems unnecessary. I always think of Mr. Shepard as a concentrate of all the enviable traits, but "concentrate" is perhaps hardly the word to apply to one of his broad-mindedness and great-heartedness—to say nothing of his stature.

Of our own oil men present as Guests little perhaps need be said, because we know so much about them. Many are already Members of the Institute, and those who are not should be. It is a good opportunity, however, with Members of the Trade Control present in Sir Frederick Godber, Mr. McColl, Mr. Heath Eves, Mr. Soubry and Mr. Carder, and Mr. Vos of the Petroleum Board, to congratulate them on the great showing the industry has made in its war effort, and on the encomiums of the Minister and the Select Committee. They in their turn must, I feel sure, be proud of their "boys in the back room." Sir William Brown and Mr. Starling, I know, would endorse these views. Mr. Starling in particular, since he is now seeing in its great war-time structure that organization which he was so largely responsible for founding in peace-time. There are other friends outside the petroleum world. We have present legislators and officials, others who have mutual purposes in professional science, and those who use the products of the industry both in the Services and commerce.

On the general principle that the customer should come first, I should like to start by welcoming the Fourth Sea Lord and the Engineer-in-Chief of the Admiralty. I imagine, by the number of repeat orders coming in, that there is no question of a reversion to coal in prospect. I might add that this could not be said of the German Navy.

In the Presidents of the Institution of Chemical Engineers and the Institute of Fuel we are strongly supported by particularly kindred societies. And the presence of Professor Fortescue of the Institution of Electrical Engineers is a graceful reminder that their own worthy President, in having so completely immersed himself in oil, has not thereby been insulated from his parent professional body.

I wish to join this Toast with another friend of old standing—Lord Sempill. Here is one whose ability and versatility are well known. At one and the same time he is an elected Peer of Scotland in the House of Lords and President of the Junior Institution of Engineers. He has been a pioneer and record-breaker in long-distance flying in light aeroplanes, and now he specializes in economics. He has served in the Royal Naval Air Force both in this and the last war and has held the rank of both Colonel and Commander. Lord Sempill has interested himself in the question of oil and fuel throughout his career. Judging by his recent address to the Institution of Civil Engineers, he has, in addition, good schemes for post-war engineering development and, what is more, for paying for it. It is perhaps of interest to know that although he has been sent in past days by the Government to teach the Japanese how to fly, he has since set that right by introducing aviation to the Greeks.

I now have the greatest pleasure in proposing the "Health of the Guests," and coupling it with the name of that great fellow-Scotsman—Lord Sempill.

THE RT. HON. LORD SEMPILL, replying to the Toast, said:

I am glad that the Toast has been proposed in a most thoughtful and generous vein by a fellow Scot. I am proud that the Council of the Institute has given me the privilege of replying on behalf of the Guests. I am particularly glad to speak for them all, and especially those from the United States of America.

A great deal has been said, and rightly said, about co-operation between the United States and Great Britain in research and development of petroleum technology and the use of the products thereof. Such sentiments cannot be repeated too often, and it is appropriate to pay a tribute to the tremendous activity in that field that those from the United States had shown, both prior to and since coming into the war.

The Minister, in an interesting and informative speech, referred to the efficiency and effectiveness of the air forces of the United Nations, and to what was owed by them to petroleum technologists. I myself, as one of the pilots at the luncheon, support that tribute to the full. The debt that the air forces owe to petroleum technologists as a whole is a very real one. The Minister might perhaps have stressed the fact that not more than 30 per cent. of the aviation fuel is made up of straight-run products, and that the remaining 70% is produced by synthetic processes. In this way petroleum technologists have made it possible for the efficiency of the combustion engine to be continuously stepped-up with the practical results that we can see to-day.

In the field of aeronautics there has always been a close co-operation between the United States and this country. The 31st Memorial Lecture of the late Wilbur Wright has just been given by Dr. Warner, Vice-Chairman of the Civil Aeronautics Board, who came over especially for this purpose. He delivered one of the most brilliant addresses on air transport that it had ever been the privilege of the Royal Aeronautical Society to hear. The field of air transport is a vital one. As the war progresses we see how dependent we are on air transports, and if the post-war world is to bring those benefits to mankind that we desire, then air transport must play a dominant part. The United States and ourselves, seeing as we do these problems from the same angle, must seek to apply the vast technical and operational experience which exists to this end.

It is impossible to mention the names of all the Guests, but I am particularly proud to mention the Fourth Sea Lord, under whom I had the privilege of serving, and I am only sorry that it was not possible for the Fifth Sea Lord, the Director of the Naval Air Service, to be present. I should also mention the Engineer-in-Chief of the Navy, the supreme technical authority of that vast and intricate machine powered with many millions of horse-power.

In the name of all the Guests I thank the President and Members of the Institute for inviting us to the luncheon, and I am sure that the feelings of the Guests for whom I speak, and my own feelings can best be summed up in the words of the sixteenth-century writer who laid down that there were five good reasons for drinking—to wit, the visit of a friend; present thirst; future thirst; the goodness of the wine; or any other reason. I feel that all these reasons have been fully satisfied on the present occasion, and I thank the President and the Members of the Institute for their hospitality.

The proceedings then terminated.

TRINIDAD BRANCH.

REPORT OF THE COMMITTEE ON THE WORKING OF THE BRANCH DURING THE SESSION 1941–42.

FIVE meetings were held during the Session, at which the following papers were read :—

26th November, 1941. *14th Annual General Meeting.* "Notes on the Decay and Destruction of Lumber, and Methods of Prevention," by R. L. BROOKS.

30th January, 1942. *68th General Meeting.* "Naval Aircraft and Aircraft Carriers," by LIEUT.-COMMANDER H. GARDNER, R.N.

27th February, 1942. *69th General Meeting.* "The Value and Accuracy of Field Measurements," by C. J. MAY and R. PIKE.

27th March, 1942. *70th General Meeting.* "Gamma-Ray Well Logging in Trinidad," by GLENN M. CONKLIN.

17th April, 1942. *71st General Meeting.* "Air-Raid Precautions," by BRIGADIER J. G. GILMAN (S.A.).

Mr. L. K. White was elected Chairman, and Mr. A. F. Castle Hon. Secretary and Treasurer.

The average attendance of members and guests at meetings was 47, but it was brought up to this figure by the attendance of ladies at the meetings when non-technical papers were read.

There were 83 members on the roll at the end of the year, compared with 78 for the previous year.

The Annual Dinner was not held on account of the War.

The sum of $99.90 was contributed to the Benevolent Fund by members of the Branch and forwarded to the parent body. The sum contributed the previous year was $103.00.

An extract from a letter from the Secretary of the parent body states :—

> "Please convey to the members of the Branch the sincere thanks of the Chairman of the Fund."

Great difficulty was experienced by the Committee in securing papers by members to be read before the Branch, and the thanks of the Committee are due to those members who gave much time and effort towards keeping the Branch in a live and useful state.

(*Signed*) A. F. CASTLE,
Honorary Secretary.

At the 79th Committee Meeting held on 12th January, 1943, the following officers were elected for 1943 :—

MR. H. C. H. THOMAS, *Chairman.*
DR. F. MORTON, *Hon. Sec. and Treasurer.*

TRINIDAD BRANCH.

BALANCE SHEET AS AT 31ST OCTOBER, 1942.

LIABILITIES.			ASSETS.		
Subscriptions to Benevolent Fund :—					
As per last Balance Sheet	$14.90		Cash at Bank		$595.27
Received during the year	99.90		Cash in Hand		4.00
	114.80				
Remitted to London during year	94.90				
		$19.90			
To be remitted to London					
Income and Expenditure Account :—					
As at 31st October, 1941	419.28				
Excess Income over Expenditure for year ended 31st October, 1942	160.09				
	579.37				
	$599.27				$599.27

INCOME AND EXPENDITURE ACCOUNT FOR YEAR ENDED 31ST OCTOBER, 1942.

EXPENDITURE.			INCOME.	
Car Hire—A.R.P. Lecture	$7.50		Grants from Institute of Petroleum, London	$191.28
Stationery, etc.	5.31			
Postages	13.97			
Telephone	4.41			
	$31.19			
Excess Income over Expenditure	160.09			
	$191.28			$191.28

(*Signed*) L. A. BUSHE,
Chairman.

A. F. CASTLE,
Hon. Sec. and Treasurer.

F. E. HUNTER
H. A. HARRIS } *Auditors.*

Minutes of the 15th Annual General Meeting, held at Apex Club House at 8.30 p.m. on 25th November, 1942.

Mr. L. A. Bushe, on the invitation of the Hon. Sec., occupied the Chair, the Chairman of the Branch being out of the Island.

1. The Minutes of the 14th Annual General Meeting were read by the Hon. Sec., and their adoption, being proposed by Mr. A. J. Ruthven-Murray, seconded by Mr. F. Penny, was agreed to unanimously.

2. The Accounts for the year 1941–42 having been circulated, Mr. Ruthven-Murray enquired what was the grant at present being received from the parent body. Mr. L. A. Bushe explained that it was formerly £40 p.a. and was now £20 p.a. £20 of the £40 shown on the Balance Sheet was due from the previous year. In reply to Mr. Ruthven-Murray's enquiry as to local revenue, Mr. Bushe stated that there was none whatever at present, the former Branch contribution of $1.00 per annum having been discontinued for some years.

Mr. A. F. Castle, replying to Mr. Ruthven-Murray, said there was a slight decrease in contribution to the Benevolent Fund over the previous year, but the amount was considerably higher than it had been three or four years previously, and remained round about $100. Mr. Bushe remarked that the Branch was in a very satisfactory financial condition.

The adoption of the Accounts was proposed by Mr. H. D. Fletcher and seconded by Mr. H. MacLea and carried unanimously.

3. The Report of the Committee on the working of the Branch during the Session 1941–42 was read by the Hon. Sec. The adoption of the Report having been proposed by Mr. F. E. Hunter, seconded by Dr. F. Morton, was carried unanimously.

4. *Election of Officers.*—Mr. Bushe informed the meeting that it was not necessary to have a ballot. There were three new members of Committee, Mr. G. F. Hazzard, Dr. F. Morton, and Dr. J. E. Smith taking the place of Mr. G. S. Taitt, Mr. H. W. Reid, and Mr. A. F. Castle.

The new Committee comprised: Dr. F. Morton, Dr. J. E. Smith, Mr. G. F. Hazzard, Mr. H. C. H. Thomas, Mr. L. A. Bushe, Mr. L. K. White, and Mr. F. W. Penny.

5. *Auditors.*—A vote of thanks to the retiring Auditors, Messrs. F. E. Hunter and H. A. Harris, was proposed by Mr. L. A. Bushe and seconded by Mr. A. F. Castle, and carried unanimously.

6. *General.*—The Chairman remarked that the Branch was in a fairly healthy state, but it was obviously going to be more difficult for people to attend meetings. The Committee did not want the Branch to die, and the only way to keep it alive was to have papers to read at the meetings.

Dr. J. E. Smith proposed a vote of thanks to the retiring Hon. Sec. (Mr. A. F. Castle). This was seconded by Mr. Bushe and carried unanimously.

There being no other business, the meeting terminated at 9 p.m., after which a paper, "The Analysis of Trinidad Crude Oils," was read by Dr. F. Morton.

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